

**Methodological challenges in observational studies
– current perspectives and future directions in
functional form, measurement error and
causal inference**

Discussion

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Talks on three very different topics

- Functional form for continuous variables
- Error in
 - measurement
 - classification of outcome
- Causal inference

For each topic

- There are several statistical approaches
- Knowledge about properties of approaches is limited
They are too complex to be handled analytically (or only under unrealistically strong assumptions) and computer intensive methods are required
- Comparison of approaches is limited
- Consequently: There is not much evidence concerning 'state-of-the-art' approaches

For many issues informative simulation studies seem to be the best way to generate evidence

For each topic

- We don't have much empirical knowledge what is done in practice

Reviewing the literature is an important task for each topic group

Across topics

The suitability of a specific approach depends on issues from other ,fields‘

- Most obvious for causal inference
- (Substantial) errors in the measurement of outcome and/or predictors can influence results severely (biased estimates, influence on selecting variables)

Laurence Freedman (Measurement Error)

Statistical methods are available

The TG4 group has started with several literature surveys

- the result is frustrating

It is known that measurement error is a (key) problem – but it's broadly ignored in practice

Reasons and problems

- Literature highlighting problems caused by ME methodology
- Inadequate standard of validation
- Difficulty finding financial support for validation studies

Michal Abrahamowicz (Functional Form)

Strong influence of the related issues variable selection (many methods) and time-dependency (for survival data)

- Categorization introduces severe problems (known for a long time) but it is still very popular
See also measurement error surveys (53%., 70%)
- Functional forms – linearity, splines or fractional polynomials?
- Many spline based methods and severe disagreement among researchers
- Large and informative simulation studies are needed (to compare spline based procedures and to compare multivariable spline based procedures with MFP)

Els Goetghebeur (Causal Inference)

- Many content experts come with causal questions and the importance of suitable methodology is rising
- Unfortunately, suitable analyses require the combination of issues such as variable selection, function selection, time dependency, handling of measurement error, handling of missing data the analyst needs to be an expert (have deep knowledge, at least) in all these areas
- Help from several relevant ‚fields‘ is required
- Even if help would be available, application is still quite demanding at the conceptual and technical level

Critical (acceptable?) assumptions are often required. Severe danger that results of analyses are mis-leading and mis-interpreted

- Analyses require often experts in many topics - very demanding for single analystst
- Each of the talks clearly illustrate severe problems in practice
- Results of literature surveys are probably still too optimistic (positive selection). We have to realize that most analyses are conducted by researchers with low statistical knowledge

The severeness of the problem is even discussed in the public press:

The Economist 'Unreliable research: Trouble at the lab.' (October 2013):

“Scientists’ grasp of statistics has not kept pace with the development of complex mathematical techniques for crunching data. Some scientists use inappropriate techniques because those are the ones they feel comfortable with; others latch on to new ones without understanding their subtleties. Some just rely on the methods built into their software, even if they don’t understand them.”

What can be done?

- Follow the successful example of reporting guidelines (<http://www.equator-network.org/>) and try to derive guidance documents
- For design and analysis guidance is required for ,analysts‘ with different levels of statistical knowledge

Level 1: Low statistical knowledge

Level 2: Experienced statistician

Level 3: Expert in a specific area

Of course: Deriving guidance for reporting is much easier than for design and analysis. A joint action is required.

What can you do?

- STRATOS aims are relevant for many methodological issues and in many areas
- Think about potential contributions to one of the 9 topic groups and/or one of the 10 cross-cutting panels of STRATOS

Topic Groups

- TG1: Missing data
- TG2: Selection of variables and functional forms in multivariable analysis
- TG3: Descriptive and initial data analysis
- TG4: Measurement error and misclassification
- TG5: Study design
- TG6: Evaluating diagnostic tests and prediction models
- TG7: Causal inference
- TG8: Survival analysis
- TG9: High-dimensional data

Panels

- MP: Membership
- GP: Glossary
- RP: Literature Review
- BP: Bibliography
- PP: Publications
- SP: Simulation Studies
- DP: Data Sets
- TP: Knowledge Translation
- WP: Website
- CP: Contact Organizations

<http://www.stratos-initiative.org/>